

CLAIMS

What is claimed is:

1. A method of providing high peak power in a pulse laser system, comprising:
5 providing a low-power, pulsed seed beam having a small beam diameter;
providing a pumped gain medium;
directing the seed beam through the pumped gain medium for a plurality of pre-amplification passes to produce an intermediate beam;
changing the beam diameter of the intermediate beam to produce a re-collimated
10 intermediate beam; and
redirecting the re-collimated intermediate beam through the pumped gain medium for at least one power amplification pass to produce a high-power output beam.
2. A method according to claim 1, further comprising:
15 directing the re-collimated intermediate beam through the pumped gain medium for multiple power amplification passes to produce a high-power output beam.
3. A method according to claim 1, further comprising:
spatially filtering the intermediate beam while increasing its effective diameter.
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4. A method according to claim 1, wherein:
the number of power amplification passes is less than or equal to the number of pre-amplification passes.
- 25 5. A method according to claim 4, wherein:
the number of pre-amplification passes is seven (7).
6. A method according to claim 1, further comprising:
controlling the re-collimated intermediate beam diameter for power amplification
30 passes so that it is closely matched to a diameter of a pumped region of the pumped gain medium.

7. A method according to claim 1, wherein:
the pumped gain medium is a Ti:Sapphire crystal.
- 5 8. A single-stage, high peak-power femtosecond kilohertz laser system comprising:
a pumped gain medium;
means for accepting an input pulse;
means for directing the input pulse through the pumped gain medium for a plurality of
pre-amplification passes to produce an intermediate beam;
10 means for re-collimating the intermediate beam to produce a larger effective beam
diameter in the pumped gain medium to produce a re-collimated intermediate beam; and
means for redirecting the re-collimated intermediate beam through the pumped gain
medium for at least one power amplification pass to produce a high-power output beam.
- 15 9. A system according to claim 8, further comprising:
means for directing the re-collimated intermediate beam through the pumped gain
medium for multiple power amplification passes to produce a high-power output beam.
10. A system according to claim 8, further comprising:
20 a spatial filter for grooming the intermediate beam while increasing its effective
diameter.
11. A system according to claim 8, wherein:
the number of power amplification passes is less than or equal to the number of power
25 amplification passes.
12. A system according to claim 11, wherein:
the number of preamplification passes is seven (7).
- 30 13. A system according to claim 8, further comprising:

means for closely matching the diameter of the re-collimated intermediate beam during power amplification passes to a diameter of a pumped region of the pumped gain medium.

5 14. A system according to claim 8, wherein:
the pumped gain medium is a Ti:Sapphire crystal.

15. A single-stage, high peak-power femtosecond kilohertz laser system comprising:
a gain medium;
10 at least one pump laser beam creating a pumped region in the gain medium;
cavity mirrors disposed upon opposite sides of the pumped gain medium, defining a cavity within which multiple passes of a signal beam through the pumped gain medium can occur;
an input mirror for directing an input beam into the cavity for multiple pre-
15 amplification passes to produce an intermediate beam;
a periscope for shifting an intermediate beam resulting from multiple pre-amplification passes;
a lens system for re-collimating the intermediate beam to produce a re-collimated intermediate beam with increased effective beam diameter;
20 one or more mirrors for directing the re-collimated intermediate beam back into the cavity for one or more power amplification passes through the gain medium; and
an output mirror for directing a high-power beam out of the system.

16. A system according to claim 15, further comprising:
25 retro mirrors for controlling beam path and trajectory within the cavity.

17. A system according to claim 15, further comprising:
a spatial filter associated with the lens system for grooming the intermediate beam while increasing its effective diameter.